U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—BULLETIN No. 89.
A. D. MELVIN, CHIEF OF BUREAU.

INVESTIGATIONS IN THE MANUFACTURE AND STORAGE OF BUTTER.

II.—PREVENTING MOLDS IN BUTTER TUBS.

BY

L. A. ROGERS,
Bacteriological Chemist, Dairy Division, Bureau of Animal Industry.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., July 14, 1906.

Sir: I have the honor to transmit herewith, and to recommend for publication as a bulletin of this Bureau, a manuscript entitled "Preventing Molds in Butter Tubs," by L. A. Rogers, bacteriological chemist in the Dairy Division. This paper is the second in a series on Investigations in the Manufacture and Storage of Butter.

Acknowledgment is made of courtesies and facilities extended by the managers of the creameries at Eagle Lake, Minn., and Bloomer, Wis., and by the Fox River Butter Company in connection with the experiments reported in this bulletin.

Respectfully,

A. D. Melvin,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATION.

PREVENTING MOLDS IN BUTTER TUBS.

There is probably no one trouble that causes butter dealers so much annoyance as the growth of molds on the inside of butter tubs. This is a trouble that is not confined to any one geographical section or to any one type of factory. It may be only an occasional outbreak even in the best managed factory, or it may become a chronic condition which the buttermaker is unable to control.

Before discussing the methods of preventing the growth of molds in tubs it will be well to consider briefly some of the characteristics of these tiny plants and the conditions under which they grow.

CONDITIONS FAVORING THE GROWTH OF MOLDS.

Molds are plants and obey certain fixed laws governing the group of which they are a type. They differ from the common plants with which we are familiar in everyday life in that they possess none of the green coloring matter by which the higher plants utilize the energy of the sun's rays in building up their tissues. Hence they live as well or better in darkness than in light, but are limited for their food supply to materials that have been prepared for them by animals or by other plants. Almost any animal or vegetable matter serves them for food. We find them growing on bread, meat, bones, damp wood, leather, and many other things. Sugars and many of the acids may be used, and we frequently find a luxuriant growth of mold on foods containing sufficient sugar or acid to prevent the growth of bacteria or yeasts.

A certain amount of moisture is necessary for the growth of molds. Growth will not occur on the surface of wood or leather unless it is allowed to remain in a damp place.

Oxygen is necessary to the development of all living things. Some of the bacteria which live only under conditions that exclude air completely seem to be an exception to this rule. These forms, however, obtain their oxygen from certain constituents of their food. The molds are unable to do this, and, like the higher plants, live only where there is at least a limited supply of air.

While a certain amount of heat is essential to the growth of molds, there is a wide range of temperature under which growth is possible. Many of the molds grow most rapidly at blood heat, but continue to grow slowly at temperatures near the freezing point. Other varieties find the most favorable conditions at lower temperatures and grow with comparative rapidity in ordinary refrigerators.

PROPAGATION OF MOLDS.

Molds reproduce themselves by yeastlike buds or by spores which correspond more closely to the seeds of higher plants. The buds, or conidia, as they are called, are easily destroyed; the spores, on the other hand, on account of their peculiar structure, resist for some time conditions that would destroy the mold itself almost instantly. Spores may be dried for years and yet under favorable conditions they will germinate and in a surprisingly short time produce a mycelium bearing millions of spores. They are able to endure much more heat than the mold itself, but are destroyed by a short exposure to boiling water. In a dry condition they are much more resistant.

Short exposures to disinfectants destroy the spores, but molds readily adapt themselves to unfavorable conditions and are frequently found growing in the presence of antiseptic sufficient to inhibit completely the growth of bacteria.

These spores and conidia are formed in enormous numbers, and on account of their minute size and exceedingly light weight are carried about by every movement of air. It is therefore almost impossible in practice to prevent entirely infection by molds. The most efficient means of holding them in check is to provide conditions unfavorable to their growth. This may be done by depriving them of one or more of the factors—food, air, moisture, or heat—which have been mentioned as essential to their growth.

GROWTH OF MOLDS IN BUTTER TUBS.

Tubs can not be made or transported without contamination, but if they are reasonably dry the spores will not germinate. If, however, the wood is not well seasoned, or if the finished tubs are held at the factory in a damp storeroom, the few spores grow and in a short time the surface of the wood is covered with a growth of mold. The tub may come from the factory in good condition and be stored in the creamery in a damp place. This may be in the ice house or next to the damp wall of the ice house or refrigerator. The growth of mold may not be noticeable without close examination. When the tubs are filled with butter, the air is excluded and the molds are unable to grow, but after a few days the evaporation of water causes the butter to shrink away from the tub, leaving a very small air space. Favorable conditions of food, moisture, and air are thus provided, and if the temperature is not too low growth will begin again.

It is a common belief that moldy refrigerators are responsible for mold in butter tubs, but from the nature of the package it is very improbable that the inside of the tub could become contaminated after it is filled. Temperature and moisture conditions that would

allow molds to grow on the wall of a refrigerator would favor the growth of molds on the inside of the tub, but the infection must come before the tub is put in the refrigerator. The growth of molds on the walls could be prevented by occasionally wiping the wall with a cloth moistened in a 5 per cent glycerin solution of corrosive sublimate. This would give the wall a thin, sticky coating in which the floating spores would be held and destroyed.

PREVENTION OF MOLDS IN TUBS.

The growth of molds in the tub may be prevented more or less successfully (1) by storing the tubs in a dry place, (2) by storing the butter at a temperature below the growth point, (3) by treating the tubs in some way to destroy the molds and their spores, or (4) by treating the tubs with some preparation on which molds can not grow.

The tubs may come to the butter maker badly infected, or he may not have at his command suitable storage. Few creameries have refrigerators holding a temperature low enough to inhibit the growth of molds if other conditions are favorable. The butter maker is therefore frequently forced to resort to the third method.

The method of steaming the tubs is often used to destroy the molds, but this has not been very effective. It is difficult to heat the tub thoroughly by a steam jet, and the sudden swelling of the tub frequently breaks the hoops.

Soaking in a brine containing about 5 per cent of formaldehyde is a method sometimes used, and one commission house recommends that the tubs be boiled in brine and that salt be rubbed on the inside before packing.

A few of the larger factories have recently begun coating the inside of the tubs and boxes with paraffin. This not only destroys the molds already present but gives a surface on which molds will not grow.

TESTING AND COMPARISON OF METHODS.

Various methods were tested and compared by the writer in a creamery which had had serious trouble with molds all through the previous summer. The test was made in October, when the temperature conditions were becoming unfavorable to the growth of molds. The factory was a new one, in excellent condition, and the refrigerator, which was better than the average, was free from molds. However, the tubs were stored in a damp room on the north side of the creamery. The practice had been to submerge the tubs on the day before they were used in a saturated brine which was boiled by blowing steam into it, and to allow them to stand in the warm brine overnight. Before packing, the sides of the tubs were coated with salt. This had not proved entirely effective.

For the experimental work thirty 20-pound tubs were secured and divided into six lots of five each. Lot I was old tubs from various sources, all showing more or less mold, while some were very moldy. Lots II, III, IV, and V were new tubs received direct from the factory. Nearly all had a ring of mold where the tubs were in contact. The tubs of Lot II were purposely wet with an emulsion of moldy cheese. Lot VI was new tubs showing no mold.

The tubs of each lot were numbered from 1 to 5. Tub No. 1 in each lot was soaked overnight in cold water in the usual way; No. 2 was boiled five minutes in a saturated brine and left in the brine overnight; No. 3 was soaked overnight in a brine containing 9 per cent of commercial formalin; No. 4 was coated on the inside with paraffin, the paraffin being applied either with a paint brush or by pouring, while hot, into the tub, which was rotated until the fluid had flowed over the entire inside surface; No. 5 was immersed for a few seconds in a bath of paraffin at 250° to 260° F. In each case the liners were soaked in a salt solution.

All of the tubs in each lot were filled from the same churning and all held in the creamery refrigerator until shipped. The first lot was held ten days, the second nine, the third eight, the fourth seven, the fifth six, and the last lot five days before shipment. The butter was shipped in a refrigerator car and was received at Aurora, Ill., six days later and was examined the following day. The results of the examination are given in the following table. In this table the tubs are described as moldy only when there was an evident increase of the mold originally on the tub.

Table showing results of experiments in treating tubs for prevention of mold.

Lot No.	Tub No.	Treatment.	Condition.
I.	1	Untreated	Tub and liner badly molded.
	2	Hot brine	No mold.
	3	Brine-formaldehyde	Do.
	4	Coated with paraffin	Do.
	5	Dipped in paraffin	Do.
II.	1	Untreated	Tub and liner badly molded.
	2	Hot brine	Do.
	3	Brine-formaldehyde	No mold.
	4	Coated with paraffin	Do.
	5	Dipped in paraffin	Do.
III.	1	Untreated	Badly molded.
	2	Hot brine	Two small spots of mold on tub and liner.
	3	Brine-formaldehyde	No mold.
	4	Coated with paraffin	Do.
	5	Dipped in paraffin	Do.
IV.	1	Untreated	Slightly moldy.
	2	Hot brine	Mold on outside.
	3	Brine-formaldehyde	Badly molded.
	4	Coated with paraffin	No mold.
	5	Dipped in paraffin	Do.
V.	1	Untreated	Tub and liner moldy.
	2	Hot brine	No mold.
	3	Brine-formaldehyde	Do.
	4	Coated with paraffin	Do.
	5	Dipped in paraffin	Do.
VI.	1	Untreated	Tub and liner moldy.
	2	Hot brine	No mold.
	3	Brine-formaldehyde	Do.
	4	Coated with paraffin	Do.
	5	Dipped in paraffin	Do.

It will be seen from this table that all of the untreated tubs became moldy. Of the six tubs treated with hot brine one was badly molded, one was slightly molded, and one had mold on the outside. Of the six tubs soaked in the brine-formaldehyde mixture one was badly molded. None of the tubs coated with paraffin showed any mold whatever, and the same was true of those dipped in paraffin.

It was evident that each of these methods checked the growth of mold materially, but that paraffining was much more efficient than the other two methods. If the temperature conditions had been more favorable to the molds it is probable that these differences would have been greater.

This test, so far as it goes, indicates that the formaldehyde treatment is more efficient than the hot-brine method. Salt is at best a weak antiseptic. Gripenberg[a] has shown that while the growth of Penicillium, the mold most commonly found on butter, is retarded by 5 per cent of salt, it will grow slowly in 10 and even 20 per cent solutions. Twenty-five per cent of salt completely checked its growth.

To treat tubs by the brine-formaldehyde method or the hot-brine method a vat should be made large enough to hold submerged the tubs used in one day. The brine may be boiled by blowing steam into it. The cost of either of these two methods is insignificant, as the bath may be used repeatedly. The objections to these methods, in addition to their inefficiency, would probably be found in the discoloring of the wood and, with the hot brine, in the excessive weight and swelling of the tub.

With paraffining not only are the molds and their spores already on the tub prevented from growing, but the wood is covered with a surface from which molds can not get nourishment. The wood is made impervious to water, and the space between the tub and the liner remains filled with water, so that the molds which may be on the liner can not get the supply of air necessary to their growth. The appearance of the tub is unchanged and is better than that of tubs soaked in brine or water.

There is no advantage in dipping the tubs over coating the inside, except that the outside will not become moldy. Dipping has the disadvantage of extra cost and giving the outside of the tub a surface which can not be marked with a pencil.

METHOD OF APPLYING PARAFFIN.

The paraffin should be applied in such a way that it will give an even, thin coating which fills all the cracks and at the same time sinks

[a] Gripenberg, R. Untersuchungen über Schimmelbildung bei Lagerbutter. Meddel Mustiala Inst. Forsoksstat Mijiriafd, Helsingfors, 1899. Review in Milch Zeitung, v. 28, No. 40, pp. 626–628; No. 41, pp. 644–646. Bremen, 1899.

into the wood sufficiently to prevent the coating of paraffin from cracking off. The application may be made with a brush, but it may also be accomplished by pouring a small amount of the melted paraffin into the tub and rotating the tub until the paraffin has flowed over the entire surface, taking care that it does not run down the outside of the tub. By the latter method a thinner, evener coating may be applied than by using a brush.

The temperature of the paraffin is important. If the temperature is too low, the paraffin will cool rapidly, making a thick uneven coating; if the paraffin is too hot, it will sink into the wood and the cracks will not be closed up. If the paraffin is melted by holding the receptacle in hot water or steam, it will be found advantageous to heat the tub over a steam jet.

The paraffin can be applied most rapidly and satisfactorily by heating it to 250° or 260° F. This may be done on an oil stove, but in creameries where steam is always available it will be better to arrange a small tank with a steam coil, as shown in figure 1.

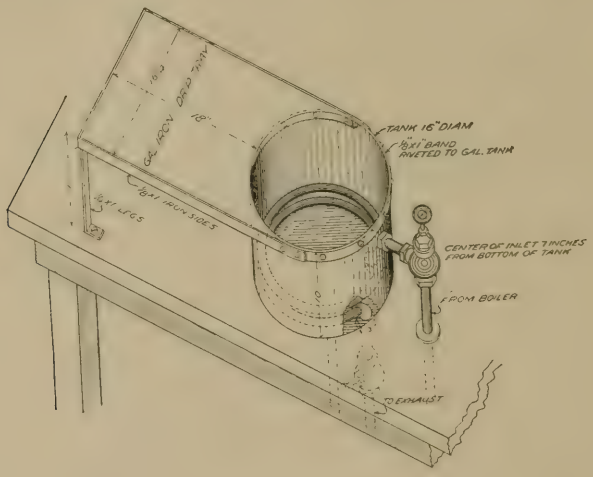

FIG. 1.—Apparatus for paraffining tubs.

By connecting the coil in the bottom of the tank with the boiler and opening the waste valve only enough to allow the escape of the water of condensation, boiler pressure may be maintained in the coil and the temperature of the paraffin raised to the required point.

COST OF PARAFFINING TUBS.

The question of the cost of paraffining tubs will doubtless be brought up as an objection to this method. The amount of paraffin necessary to coat a 60-pound tub will vary with the method of applying and the temperature of the paraffin. If the paraffin is hot enough,

this should not exceed 3 ounces per tub, and as a good grade of paraffin may be purchased at about 8¼ cents a pound the cost will be less than 2 cents per tub. But even this small sum would be a considerable item in a season's run and would be a serious objection in some factories. However, there is another factor which must be taken into consideration. In an ordinary tub the loss by evaporation from the outside and by absorption of water from the butter by the tub is an appreciable quantity. Coating the tub with paraffin makes it impervious to water, and this loss is reduced to a minimum.

To illustrate this point, 24 tubs were divided into two lots of 12 tubs each. One lot was paraffined in the manner previously described, and the other lot was soaked overnight with cold water in the usual way. The tubs were weighed before filling and again after the butter was packed. The 12 paraffined tubs contained at this time 757¼ pounds of butter and the 12 tubs soaked in water 766¼ pounds. These tubs were all filled from the same lot of butter, were held in the factory refrigerator three days, and were then shipped to the commission house, where they were weighed on the eighth day after packing. Each tub was weighed separately, and the average weight of three empty tubs was taken as the tare. The weight of butter obtained in this way was for the paraffined tubs 756 pounds, a loss of 1¼ pounds; for the soaked tubs 759 pounds, a loss of 7¼ pounds. In other words, by the use of about 15 cents' worth of paraffin the price of 6 pounds of butter was saved. In butter held in storage for any length of time this saving would undoubtedly be much greater.

It should be remembered, however, that paraffined tubs weigh from 1 to 2 pounds less than tubs prepared in the ordinary way, and unless the tare is actually determined this difference will be lost to the butter maker. This possibility may be avoided by soaking the tubs before paraffining. To do this it is necessary to keep the paraffin very hot, so that it will displace the water in the pores of the wood, or the soaked tub may be heated on a steam jet before applying the paraffin.

The labor cost of paraffining need not be greater than in the usual method of soaking tubs in cold water or brine. The apparatus needed as here illustrated is simple and inexpensive.

SUMMARY.

The advantages of paraffining may be summarized as follows:

(1) Certain prevention of moldy tubs.
(2) Prevention of mold on butter and liner by avoiding air space.
(3) Neater appearance of tub.
(4) Reduction of loss from shrinkage.

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